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METHOD AND APPARATUS FOR FABRICATING LIQUID CRYSTAL DISPLAY PANEL

[Abstract]

PROBLEM TO BE SOLVED: To solve problem that cell thickness is fluctuated due to excess or deficiency of liquid crystal dropping and defectively stuck state is caused such as mounting of a liquid crystal on a sealing, etc., in conventional liquid crystal dropping methods.

SOLUTION: An amount of the dropped liquid crystal is measured. When the amount of dropping is inappropriate, sticking operation is not carried out and the liquid crystal is recovered. Also, because no sealing is formed on the substrate to which the liquid crystal is to be dripped, the liquid crystal and the substrate are easily regenerated.

[Claims]

[Claim 1]

A method for fabricating an LCD panel for dropping liquid crystals on one substrate and then bonding two sheets of substrates, constituting an LCD panel, at a reduced pressure, wherein an amount of dropped liquid crystals is measured, and if the amount of dropped liquid crystals is not equal to a reference value, the dropped liquid crystals are withdrawn.

[Claim 2]

The method of claim 1, wherein a seal is formed on the substrate after liquid crystals are dropped.

[Claim 3]

The method of claim 1, wherein the seal is formed on the counter substrate facing the substrate on which liquid crystals are dropped.

[Claim 4]

The method of claim 1, wherein the withdrawn liquid crystals are re-used.

[Claim 5]

The method of claim 1, wherein the substrate from which liquid crystals have been withdrawn is re-used.

[Claim 6]

The method of claim 1, wherein after the amount of dropped liquid crystals

is measured, if the amount of dropped liquid crystals is not sufficient, the liquid crystals are not withdrawn but the insufficient amount of liquid crystals are added and then dropped, and thereafter, the amount of dropped liquid crystals are measured again.

[Claim 7]

An apparatus for fabricating an LCD panel comprising: a dropping unit for dropping a required amount of liquid crystals on a substrate on which a seal is not formed; a measuring unit for measuring the amount of liquid crystals which have been dropped by an electrical dropping unit; a determining unit for comparing the amount of liquid crystals measured by the measuring unit with a reference value and determining whether the amount of liquid crystals are suitable; a liquid crystal withdrawing unit for withdrawing liquid crystals and re-using it if the amount of liquid crystals is determined not to be suitable; and a substrate withdrawing unit for withdrawing the substrate remaining after liquid crystals have been withdrawn by the liquid crystal withdrawing unit, and re-using it.

[Title of the Invention]

METHOD AND APPARATUS FOR FABRICATING LIQUID CRYSTAL DISPLAY PANEL

[Detailed description of the Invention]

[Field of the Invention]

The present invention relates to a method and apparatus for fabricating a liquid crystal display (LCD) panel and, more particularly, to a liquid crystal dropping method for dropping liquid crystals on one substrate and then bonding two sheets of substrates, constituting an LCD panel, at a reduced pressure, and a fabrication apparatus therefor.

[Description of the Prior art]

An LCD panel has such a structure that, with respect to two sheets of glass substrates each with a transparent electrode thereon, a sealant is coated at an edge portion of inner facing surfaces of the substrates, and then the substrates are bonded with a gap therebetween, a liquid crystal cell is formed and sealed at the inner side of the sealant forming the gap.

As a method for sealing liquid crystals in the liquid crystal cell, a vacuum injection method has been used in which the liquid crystal cell is maintained in a vacuum state in a vacuum bell jar, air in the liquid crystal cell is exhausted, an injection opening formed at a portion of a sealant of the liquid crystal cell is put in a liquid crystal stored container and in this state the interior of the bell jar is returned to an atmospheric pressure, liquid crystals are injected into the liquid crystal cell according to the atmospheric pressure, and then the injection opening is sealed with a resin, thereby sealing the liquid crystals in the liquid crystal cell.

However, as the liquid crystal cell is being enlarged, the injection time is lengthened, so the liquid crystal injection method is disadvantages. Thus, a liquid dropping method has been proposed. That is, as shown in Figure 3, a UV-hardening resin 4 is coated at an edge portion of one glass substrate 2 by using a dispenser, the liquid crystals 5 are dropped to fill the interior by using the dispenser, and then, the two substrates are bonded. This liquid crystal sealing method is called liquid crystal dropping method, which is, for example, disclosed in a Japanese Laid Open Publication No. 63-179323.

[Problems to be solved by the Invention]

However, according to the liquid crystal dropping method, although a cell gap (cell thickness) can be determined by the amount of liquid crystals dropped at the inner side, a method for dropping a certain small amount of liquid crystals has not been established and there are many problems such as remaining air bubbles because of shortage of the amount of liquid crystals and overflowing of liquid crystals because of an excessive amount of liquid crystals. In addition, when the defective product is intended to be reproduced, because the sealant has been formed, it is not easy to withdraw liquid crystals or the substrate.

In order to solve the problems, an object of the present invention is to provide a method and apparatus for fabricating an LCD panel with excellent productivity capable of easily performing recovery/reproduction when degradation is caused because of an excessive amount of liquid crystals beyond a suitable amount.

[Means for solving the problem]

To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described herein, there is provided a method for fabricating an LCD panel, wherein an amount of dropped liquid crystals is measured, and if the amount of dropped liquid crystals is not equal to a reference value, the dropped liquid crystals are withdrawn.

In the present invention, if the amount of dropped liquid crystals is not equal to the reference value, the dropped liquid crystals are withdrawn, so that degradation due to excess or shortage of the liquid crystals can be prevented.

In the method for fabricating the LCD panel as recited in claim 2 according to the method for fabricating the LCD panel as recited in claim 1, seal formation is performed on the substrate after liquid crystals are dropped.

According to the present invention, since the seal is not formed on the substrate when liquid crystals are dropped, when the amount of dropped liquid crystals is not equal to the reference value, the seal is not mixed with the liquid crystals and only the liquid crystals can be withdrawn.

In the method for fabricating the LCD panel as recited in claim 3 according to the method for fabricating the LCD panel as recited in claim 1, seal formation is performed on the substrate facing a substrate on which liquid crystals are dropped.

According to the present invention, since the seal is not formed on the substrate when liquid crystals are dropped, when the amount of dropped liquid crystals is not equal to the reference value, the seal is not mixed with the liquid crystals and only the liquid crystals can be withdrawn.

In the method for fabricating the LCD panel as recited in claim 4 according to the method for fabricating the LCD panel as recited in claim 1, the withdrawn liquid crystals are re-used.

According to the present invention, since the withdrawn liquid crystals are re-used, the high-priced liquid crystals are not wasted and thus a fabrication cost can be reduced.

In the method for fabricating the LCD panel as recited in claim 5 according to the method for fabricating the LCD panel as recited in claim 1, the substrate from which liquid crystals have been withdrawn is re-used.

According to the present invention, since the liquid crystal-withdrawn substrate is re-used, the substrate with the electrode, the TFT or the like is not wasted, so a fabrication cost can be reduced.

In the method for fabricating the LCD panel as recited in claim 6 according to the method for fabricating the LCD panel as recited in claim 1, after the amount of dropped liquid crystals is measured, if the amount of dropped liquid crystals is not sufficient, the liquid crystals are not withdrawn but the insufficient amount liquid crystals are added and then dropped, and thereafter, the amount of dropped liquid crystals are measured again.

According to the present invention, because the insufficient amount of liquid crystals are added and dropped, and then, the amount of dropped liquid crystals is measured again, the amount of dropped liquid crystals can approach the reference value.

An apparatus for fabricating an LCD panel as recited in claim 7 includes: a dropping unit for dropping a required amount of liquid crystals on a substrate on which a seal is not formed; a measuring unit for measuring the amount of liquid crystals which have been dropped by an electrical dropping unit; a determining unit for comparing the amount of liquid crystals measured by the measuring unit with a reference value and determining whether the amount of liquid crystals are

suitable; a liquid crystal withdrawing unit for withdrawing liquid crystals and re-using it if the amount of liquid crystals is determined not to be suitable; and a substrate withdrawing unit for withdrawing the substrate remaining after liquid crystals have been withdrawn by the liquid crystal withdrawing unit, and re-using it.

According to the present invention, since degradation of the cell thickness can be reproduced easily, an apparatus for fabricating an LCD panel with excellent productivity can be provided.

[Embodiment of the invention]

The embodiment of the present invention will now be described with reference to the accompanying drawings.

Figure 1 is a flow chart of a method for fabricating an LCD panel in accordance with a first embodiment of the present invention.

A pre-processing process (S11) includes a process for cleaning or aligning a substrate with a transparent electrode formed thereon, and the substrate to be used for bonding is pre-processed.

Next, a required amount of liquid crystals is dropped on one substrate by using a dispenser (S12). A dropping amount of liquid crystals is not determined by the size of the substrate or by a gap between substrates. In case of liquid crystals with density of $1.07g/cm^3$, if a size of a substrate is 308mmx231mm and the gap between substrates is 4.5μm, the dropping amount of liquid crystals is 342mg.

After the liquid crystals are dropped, the actual amount of dropped liquid crystals is measured (S13).

The amount of dropped liquid crystals is measured through (1) an image determining method in which a liquid crystal-dropped area/plane shape of the liquid crystal-dropped substrate are measured by using a CCD area sensor or a

CCD sine sensor, (2) a weight determining method in which a weight of a liquid crystal dropping syringe is measured and then weights of before dropping and after dropping are compared, (3) a volume determining method in which a scan type laser displacement gauge is used and liquid crystal-dropped area/plane shape of the liquid crystal-dropped substrate are measured, and (4) the amount of dropped liquid crystals is checked by combining the methods (1) to (3).

After the amount of dropped liquid crystals is compared with the reference value (S14), if the amount of dropped liquid crystals is allowable, the substrate with the liquid crystals dropped thereon is delivered to a process of bonding with other substrate on which spacer spreading (S17) and seal formation (S18) have been finished, so as to be bonded with a certain gap therebetween. When bonding them, the liquid crystal-dropped substrate is positioned at a lower side and the spacer-spread substrate is positioned at an upper side. In this respect, the spread spacers are attached on the substrate owing to an electrostatic force, Van der Waar's force, a moisture absorption force, or the like, so they are not dropped. Or, adhesive spacers are adhered on the substrate in advance or a rib substrate with a concavo-convex surface formed thereon by a resin can be also used.

If the amount of dropped liquid crystals is not equal to the reference value, the dropped liquid crystals are withdrawn (S15) and the substrate is also withdrawn (S16) so as to be re-used. As a method for withdrawing liquid crystals, there can be used (1) a method for sucking liquid crystals by using a suction nozzle, (2) a method in which the substrate is slanted to allow liquid crystals to flow down to a withdrawal opening installed at a lower portion of the substrate, (3) a method in which liquid crystals are collected with an air knife and flow into a withdrawal opening installed at an outer side of the substrate, (4) combination of

the methods (2) and (3), (5) a method in which liquid crystals are collected with the air knife and then sucked by using the suction nozzle, and (6) a method in which the substrate is rotated to dissipate liquid crystals toward a withdrawal opening installed at an outer circumference of the substrate by a centrifugal force.

When liquid crystals are withdrawn, it is preferred that seal is not formed yet. If seal is formed already, the sealant is mixed with the withdrawn liquid crystals, making it difficult to re-use it. In addition, cleaning of the substrate for reproducing it is also difficult. Thus, seal is formed on the substrate after liquid crystals are dropped, or preferably, the seal is formed on the counter substrate facing the liquid crystal-dropped substrate.

The height of the seal is about twice of three times the thickness of the cell after the LCD panel is completely fabricated. With such dimension, when the seal is formed on the counter substrate facing the liquid crystal-dropped substrate, leakage of liquid crystals from the seal in bonding the two substrates can be prevented.

In this manner, the amount of dropped liquid crystals are measured, and if the amount is not equal to the reference value, liquid crystals are withdrawn and only when the amount of dropped liquid crystals is suitable, it is used in the bonding process, so defective cell thickness can be prevented.

In addition, the seal is formed on the substrate after liquid crystals are dropped, or it is formed on the counter substrate, so that withdrawal of the dropped liquid crystals and the substrate can be easy. Also, since the withdrawn liquid crystals or substrate are/is re-used, the fabrication cost can be reduced.

Figure 2 is a flow chart of a method for fabricating an LCD panel in accordance with a second embodiment of the present invention.

Descriptions on the same process of the second embodiment as in the first embodiment will be omitted. A difference of the second embodiment of the present invention is that the amount of dropped liquid crystals is checked, and if the amount of dropped liquid crystals is smaller than the reference value (S24), the liquid crystals are not withdrawn, and the process is returned to the liquid crystal dropping process (S22) to re-drop liquid crystals. In the re-dropping method of liquid crystals, a dropping condition of the dispenser is adjusted according to the insufficient amount of dropped liquid crystals and then dropping of liquid crystals is performed. For example, by controlling a dropping time of the dispenser, the amount of dropping liquid crystals can be adjusted.

If the amount of dropped liquid crystals is too much (S25), it is not easy to remove the liquid crystals as much as the excessive amount, so the liquid crystals are withdrawn (S26) and the substrate is also withdrawn (S27) so as to be re-used.

In this manner, in the case that the amount of dropped liquid crystals is not sufficient, the liquid crystals are not withdrawn and the insufficient amount of liquid crystals are re-dropped. Thus, a probability that the dropped amount of liquid crystals almost reaches the reference value increases, and thus, the yield can be enhanced.

[Effect of the invention]

As so far described, the method and apparatus for fabricating the LCD panel in accordance with the present invention has many advantages.

That is, for example, first, the amount of dropped liquid crystals is measured, and if the measured amount is not equal to the reference value, the liquid crystals are withdrawn, thereby preventing defective cell thickness.

Second, since the seal is formed after liquid crystals are dropped, or is formed on the counter substrate, the dropped liquid crystals or the substrate can be easily withdrawn.

Third, since the withdrawn liquid crystals or substrate is re-used, the fabrication cost can be reduced.

Fourth, if the amount of dropped liquid crystals is not sufficient, the liquid crystals are not withdrawn immediately and the insufficient amount of liquid crystals are re-dropped. Thus, a probability that the dropped amount of liquid crystals almost reaches the reference value increases, and thus, the yield can be enhanced.

[Description of drawings]

Figure 1 is a flow chart of a method for fabricating an LCD panel in accordance with a first embodiment of the present invention;

Figure 2 is a flow chart of a method for fabricating an LCD panel in accordance with a second embodiment of the present invention; and

Figure 3 shows a method for fabricating an LCD panel in accordance with a conventional art, of which (A) is a schematic perspective view and (B) is a schematic sectional view.